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**Magneto-structural Phase Diagram for  $\text{LuFe}_2\text{O}_4$**

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In this work we will present magnetization measurements and field-dependence diffraction on highly stoichiometric  $\text{LuFe}_2\text{O}_4$  single crystals and the related complex magnetic-temperature phase diagram. The magnetic behavior of  $\text{LuFe}_2\text{O}_4$  depends very sensitively on its oxygen stoichiometry; for high-quality samples, the compound shows a sharp antiferromagnetic transition at  $T_N \sim 240\text{K}$ . A metamagnetic transition between a ferri- and antiferromagnetic phase occurs below  $T_N$  by applying magnetic fields in the c direction. This transition does not involve any structural changes. Below 170K, frequency-dependent AC susceptibility suggests a phase with “glassy” dynamics. This glassy phase is separated from the rest of the phase diagram by a transition with structural component. The complex magnetic phase diagram likely derives from combined ferri- and antiferromagnetic clusters and a structural distortion. Neutrons also indicate a magnetic cluster structure with shorter correlation length for the “glassy” state. The latter accounts for an apparent kinetic hindrance of a transition between two of the phases, leading to a very high value of coercivity  $>9\text{T}$  at low temperatures. The structural transition has also a time dependence on the scale of hours.